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Doubly charged ions are studied to elucidate the limits of their stability and reactivity. This project supplements a parent grant to study the molecular spectroscopy, reaction kinetics, and theory of dication species. Support in this project is for the specific training of graduate students involved in the experimental preparation and study of these species.

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SUPPLEMENT
for
Theoretical/Experimental Investigations of the Structure and Dynamics of Highly Energetic Dication Species

W. Carl Lineberger
S. R. Leone
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30 June, 1995

During the past year, ASSERT scholar Joseph Kim and graduate student Jim Smith have been working on the coaxial laser-ion spectrometer which had previously been utilized to elucidate the dissociation dynamics of dications. The thrust of his work has now changed, to emphasize studies of dynamics in ionic clusters where the cluster consists of a fuel oxidant and an ionic core. The first step in making this transition concerned efforts to produce cold ions and cluster ions in the coaxial beam machine. Mr. Kim has made major modifications to the ion source, installing a pulse supersonic expansion and a new electron beam system to enable the production of cold cluster ions. There have been a number of technical details associated with the production of cold ions which have slowed progress in the last year. There were many problems associated with electrical breakdown in the floating ion source and with collisional heating of the ions. All of these problems have now been solved, and we are able to produce cold cluster ions on a relatively routine basis. The best "thermometer" to characterize the ion source has proven to be the rotational temperature of OH^-. The first photodetachment spectra of OH^- are being obtained by Mr. Kim at present, and he has already demonstrated surprisingly sharp photodetachment thresholds. It appears that the long range forces involved with the OH permanent dipole moment dramatically alter the photodetachment threshold law, greatly increasing the rate at which the cross section rises very near threshold. This sharp rise will be a very important diagnostic in the studies of the structure of cluster ions. The studies of cluster ions using these continuous laser techniques will be complemented by studies on our ultrafast dynamics apparatus using the Ti:sapphire laser systems. To assist us in developing this technology rapidly, we are collaborating actively with Dr. Gustav Gerber (Würzburg), to obtain very short pulses from Ti:sapphire oscillators. A publication describing this work should be complete in the near future.